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SP701-B Using Switchgrass for Forage

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Switchgrass is a warm-season perennial grass native to much of the United States. Over the last few years, switchgrass has received renewed interest as a renewable fuel source, since it produces large amounts of cellulose that can be digested and converted to ethanol. The high yields and environmental adaptability of switchgrass make it an excellent choice for biofuel feedstock production.

While there has been a great deal of media attention about the merits of switchgrass as a biofuel feedstock, many are less familiar with the potential of switchgrass as a forage crop. Switchgrass, like a number of other native warm-season grasses (NWSG), can actually produce high-quality forage. Yields of 2-5 tons per acre can be expected, depending on rainfall and soil type, as well as other environmental conditions. The nutrient content of this forage can be as high as 16-17 percent crude protein, if harvested correctly.

Characteristics that make switchgrass attractive as a forage crop

- ***High yields*** – Switchgrass grown for forage can produce up to twice as much as tall fescue on an acre of land. Research in Tennessee has shown that, if grown exclusively for hay, 4-5 tons per acre are not uncommon. If switchgrass is planted primarily for biofuels production, there is potential to harvest the early growth through haying or grazing, then managing the remainder of the season's growth for the biofuels feedstock market.
- ***Summer hay production*** – Since switchgrass is a warm-season grass, it is adapted to hot, summer conditions. As peak growth occurs from May through September, it is easy to produce hay because of better drying conditions. It is not unusual to find switchgrass hay that is better quality than the average tall fescue hay. This is not because switchgrass as a species is better than tall fescue, but because hay-making conditions are better during the switchgrass growing season and because rain and cool temperatures often delay cutting tall fescue. A delayed tall fescue harvest results in decreased protein and energy.
- ***Summer grazing*** – The summer growth of switchgrass also makes switchgrass an excellent forage for grazing. Since most cattle operations in the Mid-South use tall fescue as their primary pasture grass, there is limited forage production during summer. This limited production

reduces the performance of grazing cattle, and may lead to overgrazing and weakened stands of tall fescue. Switchgrass can provide good-quality forage for grazing animals and provide the opportunity to rest tall fescue pastures during a stressful time of the year.

Research has shown switchgrass can be grown successfully as both a biofuel feedstock and forage crop. There is no need, however, to grow it as only one or the other. There is the possibility of having switchgrass as a "dual-purpose" crop. The early growth of the forage, which is generally the highest quality, can be hayed or grazed. The later growth can be allowed to mature and harvested after frost as a biomass crop. Biomass production will be lower under this scenario, but, depending on the objectives and needs of the producer, this may be a useful strategy.

Keys to using switchgrass as a hay crop

Early-season production (late April–late May for switchgrass) produces the highest-quality forage and can be easily utilized for hay. Crude protein levels may range from 14-20 percent at this time of year. However, forage yields will be relatively low (e.g., two tons per acre, depending on the timing of harvest). As with any hay crop, waiting a few weeks will increase forage yield and decrease forage quality (Figure 1). In addition, the later the forage is harvested, the greater the reduction in the final biofuel feedstock harvest for that season. Most biomass accumulation in switchgrass occurs in the first half of the growing season. For example, in one Southeastern study, 56 percent of annual biomass accumulation was obtained by late June each year. Obviously, delaying the forage harvest too late (past late-boot stage) would also be counterproductive for forage production, because of drop in forage quality in the maturing stand.

These early-forage harvests (haying or grazing) should leave a minimum 8-inch residual height to ensure rapid regrowth and an adequate final biomass harvest. Producers must realize that leaving high residual heights is very important to quick recovery of the plant, due to the elevated growing point on switchgrass (often > 5 inches above the soil surface) and the minimal leaf surface area present below 8–10 inches. Removing the growing point and all leaves will result in delayed regrowth that will substantially reduce final yields and, in the long run, stand vigor.

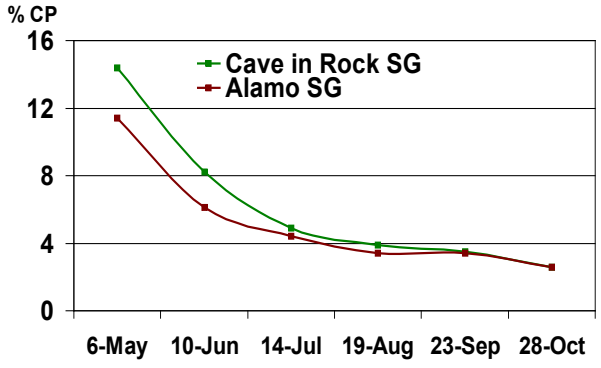
Because biorefineries will require switchgrass on a year-round basis, producers would have the opportunity to later sell switchgrass harvested for hay as biofuel feedstock if they find they do not need as much as hay. While dormant-season harvested material is considered better quality for biofuel production as a result of reduced mineral concentrations, there is no reason to believe mid-summer "hay" crops will not be acceptable for processing switchgrass into biofuel. Following guidelines for proper hay storage will help ensure the material will be available for future hay needs or biofuel production.

Caution about Horses and Switchgrass Hay: While switchgrass hay has excellent value for beef and/or dairy cattle, as well as other livestock, there is evidence that horses fed switchgrass hay may have a phototoxic reaction. In short, horses may lose some hair and suffer sunburns. Although it is not common, horse owners should be aware of this problem. At this time, switchgrass is **not recommended** for horse hay.

Grazing Switchgrass

Because early-season switchgrass has good nutritive value for cattle, the material could be removed through controlled grazing rather than haying. Grazing, of course, requires adequate fencing, access to water and shade. Where this infrastructure is lacking, the investment may not be cost-effective. This is due to the relatively short grazing season available in an integrated system where a good deal of switchgrass growth will be reserved for biofuels. On the other hand, temporary fencing and leaving gates open to water on other pastures could be effective. This strategy will be even more effective later in the spring when the quality and production difference between cool-season grasses and switchgrass is more pronounced.

Figure 1. Crude protein changes with maturity in two switchgrass cultivars.



Source: Sladden and co-workers.1994. American Forage and Grassland Council Conference Proceedings p. 242

Because of the reasons listed under haying guidelines, it is important not to graze switchgrass too closely. Leaving a residual stand height of at least 8 inches, and preferably as high as 12 inches, will result in more rapid regrowth and greater yields of biomass for biofuels at the end of the season. While most producers managing switchgrass strictly as a forage crop will practice rotational grazing to accommodate this growth, it is unnecessary when attempting to integrate grazing and biomass production. That is because a single rotation of only 2–4 weeks of grazing should be planned. Switchgrass could be grazed later into the season, but as with haying, increased consumption as a forage crop will reduce final biomass yields.

Initial livestock entry into switchgrass in the spring should occur once the stand is 18–24 inches tall, typically mid-May. Stocking at lower rates or creep-grazing calves will make it possible to begin sooner. Stocking rates of three to five steers per acre will probably be best under normal circumstances. This should allow enough animals to remove the available forage within a 2–4 week period, freeing up the remainder of the growing season for accumulation of switchgrass feedstock for biofuels. Experience will dictate how to adjust these stocking rates to achieve desired results. Keep in mind, during the establishment year, no grazing should be planned unless it is a brief period of high stocking to remove a weed canopy. During the second year of the stand, there will be production, but it will likely be only 50–70 percent of the stand's potential. It is important to not overgraze the stand this second year to enable the root system to fully develop. Such a system will ensure full production levels in future years and promote considerable stand longevity typical of switchgrass (> 15 years).

Fertilization of Switchgrass for Forage Production

Even though switchgrass is adapted to poor soil fertility, producing large amounts of high-quality forage requires adequate levels of potash, phosphate and nitrogen. Research has shown that pH has limited effect on switchgrass yield. Current recommendations are that pH should be maintained at 5.0 or higher. There is no need to lime to keep pH at levels needed for most other forage crops. Nitrogen should be only be applied to native grasses if soil moisture is not limiting, and if extra forage production is desired (Table 1).

Table 1.
Nitrogen fertilization recommendations for switchgrass used for forage.

Use	Early summer	Mid-summer
	---------- lb actual N per acre ----------	
Hay[1]	45-60	45-60
Grazing[2]	45-60	up to 60 lb N

[1]Mid-summer application should be eliminated if soil moisture is limited
[2]Apply N only if extra forage growth is needed.

Summary

Even though many people are currently focused on switchgrass as a biofuel feedstock, it should be kept in mind that switchgrass can also be used as a forage crop. High yields and good-quality forage can be produced during summer, if it is managed correctly. If switchgrass is cut while it is young and leafy, the nutrient content will be equal

to other grasses. If switchgrass is allowed to mature and become fibrous, forage quality will suffer drastically. This is noteworthy; given the tendency of switchgrass to produce high amounts of fiber when mature is what makes it desirable for biofuel production.

It should also be kept in mind that this crop does not have to be used only for forage or only for biomass. It can be harvested as a dual-purpose crop, so early growth can be used for forage, and later growth can be used for biomass. Haying early may reduce biomass production, but the ability to use some of the growth for cattle production will add flexibility to a producer's operation and provide the opportunity to increase profitability.

What about Other Native Grass Species?

Selection of grasses other than switchgrass can enhance the stand as forage and wildlife habitat. Grasses such as big bluestem, little bluestem and indiangrass have been planted along with switchgrass to form a mixed-grass stand. Each of these grasses has a slightly different maturity date, which spreads out the potential timing of quality forage harvest. These mixtures also contribute to a different sward structure, which can provide better wildlife habitat than a single grass species. There is also the possibility to use legumes to improve forage quality and to replace nitrogen fertilizer. Research is still needed to identify the proper legume species and management techniques for successful use of legumes in the stands. Therefore, each producer must consider his or her individual goals and the potential trade-offs between switchgrass yields, forage potential and wildlife habitat enhancement.

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